DOCUMENT RESUME

ED 128 202 SE 021 282

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TITLE 1965-1975: Achievement and Analysis of Computation Skills, Ten Years Later.
PUB DATE [75]
NOTE 14p.; Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Achievement; *Basic Skills; *Educational Change; Elementary Education; *Elementary School Mathematics; Instruction; Mathematics Education; *Research; Standardized Tests; Tests
IDENTIFIERS Research Reports

ABSTRACT

This research compared achievement of sixth graders in ten Michigan schools for the years 1965 and 1975. The "fundamentals" part of the California Achievement Test was the basis of comparison; school records were used to gather data on age, sex, and IQ of students in the two samples. School personnel were interviewed concerning prevailing instructional practices at the schools. The teachers of the students tested in 1975 were given a questionnaire. Data were submitted to analysis of variance using classrooms as the unit of analysis. Results indicated that, contrary to the national trend, computational skills were maintained in the ten schools studied. Stability in achievement scores was associated with a relatively stable teaching staff and lack of major socioeconomic changes in the school population. Changes in textbook series and school organization did not appear to affect overall achievement, although individualization in some schools seemed to benefit some skills at the expense of others. (SD)

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ED128202

REPORTING SESSION

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1965-1975: Achievement and Analysis of Computation Skills Ten Years Later

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Purpose and Significance

This research study was undertaken for the purpose of answering two different but related questions. The first, a substantive one, "Do the computation skills of sixth grade pupils in a southeastern Michigan school district in 1975 differ significantly from those of a similar group a decade earlier in 1965?" The second, a procedural one, "Can achievement of computation skills be more accurately measured and reported with an altered and expanded research design, utilizing statistical procedures which are available in 1975, but which were not widely used in 1965?" Specifically, what effect upon results will be evident if the unit is defined as a class rather than as an individual, and if multivariate and/or pattern analysis is employed rather than analysis of variance and covariance?

Conceptual Framework

The following assumptions provide a framework of meaning for the collection and analysis of data describing computation skills of sixth grade pupils.

1. Computation skill is a major goal, but not the only goal of elementary mathematics instruction.
2. A high level of computation skill should be maintained in any sound elementary mathematics curriculum.

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3. Computation skill is influenced by many variables. Student ability, program, method, and teacher are several of the most frequently acknowledged influences.
4. The current criticisms of "modern math" admittedly have some basis in reported lower achievement scores, but these may be over generalized or inaccurately interpreted.
5. The rationale for the expansion of the research design can be found in the description of newer statistical procedures which attempt to improve analysis of related variables by examining them as components of an inter-related group, rather than as a series of simple and separate variables.

Procedures

The California Arithmetic Test (Part II - Fundamentals [80 items]) was administered to sixth graders in ten schools at the end of the school year, 1975, by the writer. The same test had been given in the same district at the same time in 1965. School records were the source of descriptive variable data: age, sex, and I.Q.- total, language, and non-language. (Intelligence data were derived from the California Test of Mental Maturity in 1965, and from the California Short Form Test of Academic Aptitude in 1975.) The mathematics coordinator was interviewed and the sixth grade teachers surveyed to determine the prevailing organizational practices, the methods and textbooks

in most common use.

Analysis

Analysis of variance (ANOVAR) and analysis of covariance (COVAR) with the three I.Q. scores as covariates were employed to measure mean differences in total computation, addition, subtraction, multiplication, and division. A histogram program revealed the percentage of students correct on each of the 80 items in 1975. These data were then compared to similar 1965 data. (Data summaries are attached.) The above constitutes a replication of the computation section of the 1965 study. The expansion of the research design to include multivariate and/or pattern analysis will commence in May, 1976, and should be completed during the summer, 1976. Differences in percentage correct data will be tested for significance also during this time.

Results and Conclusions

This section is prefaced with the comment that the findings vary somewhat with the statistical procedure being followed, and the caution that conclusions which seem apparent from initial analysis are refined as subsequent, more specific analyses are employed. The 1965 and 1975 groups did not differ significantly in total I.Q. means.

Findings:

1. There is no significant difference between the 1965 and 1975 groups in total computation revealed by analysis

of covariance with either total I.Q. or language I.Q. as covariate. The use of non-language I.Q. as covariate alters this result to favor the 1965 group, and calls attention to an interesting but atypical pattern of intelligence data evidenced by the 1975 group - a higher non-langugae I.Q. than total or language I.Q.

2. The 1965 group is significantly favored in addition and subtraction, when ANOVAR or COVAR with any one of the three I.Q. scores as covariates is employed.
3. There is no significant difference between the 1965 and 1975 groups in multiplication revealed by any analysis.
4. The 1975 group is significantly favored in division at the .04 level when COVAR (total I.Q.) is used, and at the .007 level when COVAR (language I.Q.) is used. There is no significant difference between the 1965 and 1975 groups when ANOVAR and COVAR (non-language I.Q.) are used.
5. For individual items of computation, the 1975 group scored higher than the 1965 group on 10 of 20 addition items; 11 of 20 subtraction items; 13 of 20 multiplication items; and 16 of 20 division items. (Note: The 1965 group mean for addition and subtraction was significantly higher than that of the 1975 group.)

6. For individual items of computation, the 1975 group scored higher than the 1965 group on all 33 whole number items, but scored lower than the 1965 group on 20 of 30 fraction items, and on 5 of the 8 decimal items. (Note: The 1975 group matched the 1965 group in fraction/division items, and surpassed them in decimal/division items.)

Socioeconomic Information

Constraints of time and the sensitivity of current climate concerning privacy of records precluded a comparison of socioeconomic level using the occupation of the family's main wage-earner (the 1965 criterion of socioeconomic level). Interviews with personnel employed in offices or agencies which could conceivably have had some comparative socioeconomic data on file proved unsuccessful. Census data were too dated to be meaningful and the ten elementary schools in this study did not comprise the total group of district schools, compounding the problem. Two facts which can be stated are that the total enrollment at the elementary level has declined about 10%, while the ADC total has risen. These are not simple mathematical issues, however, so no ratio conclusions can be drawn.

Most administrators expressed the opinion that the ten schools in the study represented the total range of socioeconomic levels in the district and were quite stable during the decade, 1965-75. What few evident changes there were occurred in other elementary schools which they named and which were not in the study.

Teacher Data

An informal and voluntary questionnaire was given to the 21 teachers whose classes were included in the testing; 18 were returned. Years of elementary teaching experience ranged from 2 to 17 years with a mean of 9 years. Eight of the 18 reported experience teaching SMSG from 1 to 4 years with a mean of 2.5 years. Five of the 18 had participated in earlier years of this testing project between 1965 and 1968. (Teachers received no more than two weeks' notice that testing was approved again for 1975.) No data were available for the 1965 teacher group, except for their names. In the writer's memory and by inference from the 1975 data, the mean years of teaching experience was less and certainly the in-service training for SMSG for those who participated in SMSG was more recent.

Textbooks and Individualizing

In 1965,the original year of the study, the SMSG series had been in use for three years in the schools tested. Addison-Wesley was adopted for the 1965-68 period, and in the intervening years the trend has been toward increasing use of multiple texts. In 1975, four series had been identified as "basic texts" and all schools were encouraged to use all four of them. It was reported that no school uses only one text. "Mathematics Prescription Resource Document", a continuous progress format for mathematics education, K-12, is based upon those four textbook series and was developed by a 1971 project team, revised in 1972 by a summer team, and again in 1974 by the six-member Individualized Mathematics Study Committee, with the director of

mathematics education as facilitator. The stated philosophy is "to teach each child in such a way as to allow him to succeed at his own rate."

In the questionnaire, teachers reported a clear perference for both the Addison-Wesley and the Houghton-Mifflin series, with these two receiving more frequent use than Harcourt Brace or American Book Comapny. Three teachers use Addison-Wesley exclusively, and 13 use it often. Houghton-Mifflin is used often by 12 teachers. The reality of multiple text use was reported by six teachers who use all four texts, four teachers who use three of the four texts, and the eight remaining teachers who use two of the four texts.

When presented with a variety of ways to meet individual differences, and asked to check any which they were actually using in their classrooms, 16 checked "continuous progress" (for 1-5 years); 13 checked informal ways as well as continuous progress; 2 checked that they meet individual differences without individualizing; and 1 failed to check any of the above. When questioned about grouping across classrooms, 16 responded that their students remain in their own rooms for mathematics, and two indicated but did not explain why/how some students went to another classroom for mathematics.

The role of CAI, computer-assisted instruction, as a supplement to regular classroom instruction is not entirely clear. Two schools employed it extensively, while eight used it very little or not at all. Student experience with CAI was reported as averaging three years per student in the one school, and three and one-half years per student in the other, with every student except one reporting such experience much of which was during later

elementary grades. For the remaining eight schools, the students did not even understand the question until explained, when a few mentioned having had it in the primary grades, usually for no more than one year.* Future analyses will investigate this variable further.

Conclusions

1. Computation skills in this southeastern Michigan school district have been maintained, contrary to the trend noted by critics nationally.
2. A relatively stable staff with a high mean (9) for years of elementary teaching experience may be recognized as one of the positive influences in this maintenance of computational skills achievement.
3. The lack of any major socioeconomic change, evident or documented, can also be interpreted as a positive factor in maintenance of computational skills achievement.
4. Changes in textbook series and organizational patterns (individualizing) have generated no significant improvement or loss in total computational skills achievement. (Some may view "no significant loss" as success in the prevailing climate of criticism?)

*Only 32 of 294 students reported such experience, with 18 of them in one school (for one year) and 14 distributed in the remaining seven schools.

5. In a school system where the use of multiple textbook series and individualizing have been encouraged for the past five or six years, some specific computational skills have been improved apparently at the expense of others. Item analysis data indicate the superiority of the 1975 group with whole numbers and the division operation, compared to the 1965 group. The 1975 performance with fractions and decimals (except for the division operation) is clearly less adequate than the 1965 group performance.

These conclusions raise some questions about objectives and priorities. Does "succeeding at one's own rate" mean remaining with whole numbers and not getting to fractions for many students? Must increased skill with specific operations or sets of numbers be at the expense of other such specific skills? Should individualizing raise the general level of computational skills achievement? Should the priority for computational skills achievement be at the expense of decreased understanding? Does the evaluation of the mathematics education program include all of the stated objectives? Individual school systems should consider all of these questions when planning procedures or interpreting evaluative data concerning computational skills.

(A subsequent report will present additional analyses of data collected in this study. Subgroups will be studied for answers to questions concerning related variables, CAI, and the higher achievement level demonstrated in division skills.)

COMPUTATION SKILLS - Grade 6 - 1965 and 1975

California Arithmetic Test: Fundamentals

Group 1 - 1965, N=305, Ten schools
Group 3 - 1975, N=386, Ten schools

VARIABLE	GROUP	ANOVAR. MEAN	DIFF.	SIG.	S.D.
Total I.Q.	1	102.76	.16	NS	14.76
	3	102.92			12.31
Non-Language I.Q.	1	101.45	1.63	NS	15.46
	3	103.08			12.71
Language I.Q.	1	103.58	1.35	NS	14.47
	3	102.23			13.12
Computation Total (80 items)	1	44.131	1.064	NS	
	3	43.067			
Addition (20 items)	1*	12.751	.699	.01	
	3	12.052			
Subtraction (20 items)	1*	11.908	.696	.01	
	3	11.212			
Multiplication (20 items)	1	10.046	.147	NS	
	3	9.899			
Division (20 items)	1	9.4093	.494	NS (.0696)	
	3*	9.9042			

COMPUTATION SKILLS - Grade 6 - 1965 and 1975

California Arithmetic Test: Fundamentals

Group 1 - 1965, N=305, Ten schools
Group 3 - 1975, N=386, Ten schools

	VARIABLE	GROUP	ANOVAR. MEAN	COVAR. ADJ. MEAN	DIFF.	SIG.
COVARIATE: TOTAL IQ	Computation Total (80 items)	1	44.131	44.799	1.158	NS
		3	43.067	43.641		
	Addition (20 items)	1*	12.751	12.926	.724	.001
		3	12.052	12.202		
	Subtraction (20 items)	1*	11.908	12.088	.721	.001
		3	11.212	11.367		
	Multiplication (20 items)	1	10.046	10.204	.169	NS
		3	9.899	10.035		
	Division (20 items)	1	9.4098	9.563	.473	.040
		3*	9.9042	10.036		
COVARIATE: LANGUAGE IQ	Computation Total (80 items)	1	44.131	44.383	.382	NS
		3	43.067	44.001		
	Addition (20 items)	1*	12.751	12.817	.522	.026
		3	12.052	12.295		
	Subtraction (20 items)	1*	11.908	11.976	.514	.028
		3	11.212	11.462		
	Multiplication (20 items)	1	10.046	10.107	.018	NS
		3	9.899	10.125		
	Division (20 items)	1	9.4098	9.467	.649	.007
		3*	9.9042	10.116		
COVARIATE: NON-LANG. IQ	Computation Total (80 items)	1*	44.131	44.965	1.930	.009
		3	43.067	43.035		
	Addition (20 items)	1*	12.751	12.970	.927	.000
		3	12.052	12.043		
	Subtraction (20 items)	1*	11.908	12.134	.930	.000
		3	11.212	11.204		
	Multiplication (20 items)	1	10.046	10.238	.347	NS
		3	9.899	9.891		
	Division (20 items)	1	9.4098	9.604	.292	NS
		3	9.9042	9.896		

*Significant difference favors this group.

THE NUMBER OF STUDENTS CORRECT ON 80 INDIVIDUAL ITEMS OF COMPUTATION, EXPRESSED AS A PERCENTAGE OF THE GROUP, 1965 and 1975

ADDITION					SUBTRACTION				
	% Correct		Difference			% Correct		Difference	
Item Type	1965	1975	Sign	Size	Item Type	1965	1975	Sign	Size
1. WN	89.9	97.4	+	7.5	1. WN	85.9	93.3	+	7.4
2. WN	91.4	97.9	+	6.5	2. WN	88.5	94.3	+	5.8
3. WN	91.2	96.1	+	4.9	3. WN	82.7	91.7	+	9.0
4. WN	87.7	89.4	+	1.7	4. WN	87.7	93.0	+	5.3
5. WN	82.7	92.5	+	9.8	5. WN	79.4	90.4	+	11.0
6. WN	92.4	96.4	+	4.0	6. WN	67.2	71.8	+	4.6
7. WN	73.2	79.0	+	5.8	7. WN	56.5	69.2	+	12.7
8. Mon	59.9	71.8	+	11.9	8. Mon	56.0	64.8	+	8.8
9. Mon	33.2	30.8	-	2.4	9. Mon	33.5	26.9	-	6.6
10. RNF	71.3	66.6	-	5.2	10. RNF	78.8	79.0	+	0.2
11. RNF	55.3	47.9	-	7.4	11. RNF	74.6	75.9	+	1.3
12. RNF	75.8	80.6	+	4.8	12. RNF	50.0	49.7	-	0.3
13. RNF	57.4	51.8	-	5.6	13. RNF	44.8	44.3	-	0.5
14. RNF	53.2	45.3	-	7.9	14. RNF	75.7	78.5	+	2.8
15. RNF	45.4	43.5	-	1.9	15. RNF	26.1	8.8	-	17.3
16. RNF	35.0	33.2	-	1.8	16. RNF	34.9	24.9	-	10.0
17. RNF & DEC	25.6	19.7	-	5.9	17. RNF & DEC	26.8	14.8	-	12.0
18. DEC	37.1	21.2	-	15.9	18. DEC	25.5	16.8	-	8.7
19. DEC	27.7	19.9	-	7.8	19. DEC	29.2	19.7	-	9.5
20. DEN	22.6	26.9	+	4.3	20. DEN	23.7	13.7	-	10.0

KEY:

WN	Whole Numbers
Mon	Money
RNF	Rational Number/Fraction
DEC	Decimal
DEN	Denominate

THE NUMBER OF STUDENTS CORRECT ON 80 INDIVIDUAL ITEMS OF COMPUTATION, EXPRESSED AS A PERCENTAGE OF THE GROUP, 1965 and 1975

MULTIPLICATION					DIVISION				
	% Correct		Difference			% Correct		Difference	
Item Type	1965	1975	Sign	Size	Item Type	1965	1975	Sign	Size
1. WN	87.0	91.5	+	4.5	1. WN	84.9	91.7	+	6.8
2. WN	88.0	91.2	+	3.2	2. WN	85.3	93.5	+	8.2
3. WN	77.2	83.9	+	6.7	3. WN	84.9	88.9	+	4.0
4. WN	81.9	85.2	+	3.3	4. WN	64.6	71.8	+	7.2
5. WN	66.8	73.3	+	6.5	5. WN	65.1	72.5	+	7.4
6. WN	53.5	69.7	+	16.2	6. WN	42.5	44.8	+	2.3
7. WN	59.2	68.9	+	9.7	7. WN	68.1	76.9	+	8.8
8. WN	55.4	65.8	+	10.4	8. WN	30.3	44.6	+	14.3
9. WN	41.3	46.1	+	4.8	9. WN	51.0	54.4	+	3.4
10. RNF	56.7	44.0	-	12.7	10. WN	25.3	30.6	+	5.3
11. RNF	46.5	44.8	-	1.7	11. RNF	41.2	36.0	-	5.2
12. RNF	42.8	38.1	-	4.7	12. RNF	22.3	26.2	+	3.9
13. RNF	28.3	30.8	+	2.5	13. RNF	18.9	24.4	+	5.5
14. RNF	45.5	28.8	-	16.7	14. RNF	61.0	57.3	-	3.7
15. RNF	21.4	14.5	-	6.9	15. RNF	26.5	33.4	+	6.9
16. RNF	18.8	13.7	-	5.1	16. RNF	19.3	18.9	-	0.4
17. RNF	10.2	11.9	+	1.7	17. RNF	20.5	17.9	-	2.6
18. DEC	53.4	60.6	+	7.2	18. RNF	29.9	34.2	+	4.3
19. DEC	13.9	9.8	-	4.1	19. DEC	34.8	43.5	+	8.7
20. DEN	13.2	18.1	+	4.9	20. DEC	13.7	30.3	+	16.6

KEY:

WN	Whole Numbers
Mon	Money
RNF	Rational Number/Fraction
DEC	Decimal
DEN	Denominate